Space Weather Technical Forecast

Issued on Tuesday, 02 November 2021 at 00:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further M-class flares. Slight chance of G1/Minor geomagnetic storms throughout the forecast period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: There are three sunspot regions on the visible disc with moderate solar activity observed over the last 24 hours. The moderate activity was a result of an M-class flare at 01/0145UTC from the region AR2887 (Cso/Beta), which resulted in a CME which may glance the earth. This region also produced a further long period flare which peaked at C4.4 at 01/2158UTC and produced a CME which is awaiting analysis. AR2891 (Dac/Beta) close to the central meridian of the northern hemisphere has become slight more complex through the last 24 hours, but has not produced any significant flares in that period. AR2893 (Hsx/Alpha) in the northeast quadrant appears stable and benign.

Solar Wind / Geomagnetic Activity: Solar wind parameters appeared to indicate a declining CME influence until the apparent shock ahead of a further CME at 01/1755UTC. Solar wind speeds, after following a decline, have increased to reach around 430km/s since 01/1755UTC. Density was around or slightly above average until 01/1230 when peak densities started to increase and wane in an oscillating pattern, peaking at 41ppcc at 01/2130UTC. Although this is not a classic pattern of a CME shock, data will continue to be analysed to determine if the density increase becomes sustained. Total IMF, Bt, was below average, but increased to moderate levels following the apparent shock, reaching 15nT between 01/1952UTC and 01/2007UTC. The north-south component, Bz was near neutral, but in line with the shock began to fluctuate between peaks of +15nT and -11nT from 01/1721UTC. Phi angle as initially weakly positive (away from the Sun) but has become variable since 01/1343UTC and indeterminate since 01/1843UTC. Geomagnetic activity has been mainly Quiet, with an Unsettled interval between 01/2100-01/2400UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured by GOES-16 remained slightly elevated but below the S1 level. The high energy electron flux (greater than 2 MeV) was mainly at background levels with the associated 24-hour electron fluence below the Active (1e8 integrated pfu) threshold, and with 2.84e6 integrated pfu recorded at 02/0000 UTC.

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Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to remain mainly low through the next four days, but with a continuing risk of M-class flares from the two most complex regions.

Solar Wind / Geomagnetic Activity: A possible recent CME arrival may lead to elevated solar wind speeds on day 1, with a current upward trend. A high speed stream is then forecast to connect with the earth on day 2, perhaps reaching speeds of 500km/s. Further CMEs may glance the earth on days 3 and 4, although these are considered to be low probability. Unsettled geomagnetic conditions are forecast to predominate through the next four days. There is a slight chance of Active or G1/Minor Storm intervals through the forecast period, due either to the onset of the high speed stream, CME effects, or combinations of these events.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be below the S1 minor storm level, and generally decreasing towards background values. The high energy electron flux (greater than 2 MeV) is forecast to be at mainly background to moderate levels, with a slight chance of reaching sustained moderate or occasionally high levels by the end of the forecast period. Corresponding 24 hour electron fluence values are expected to remain below the Active (1e8 integrated pfu) level, although a rising trend is possible through days 3 and 4.

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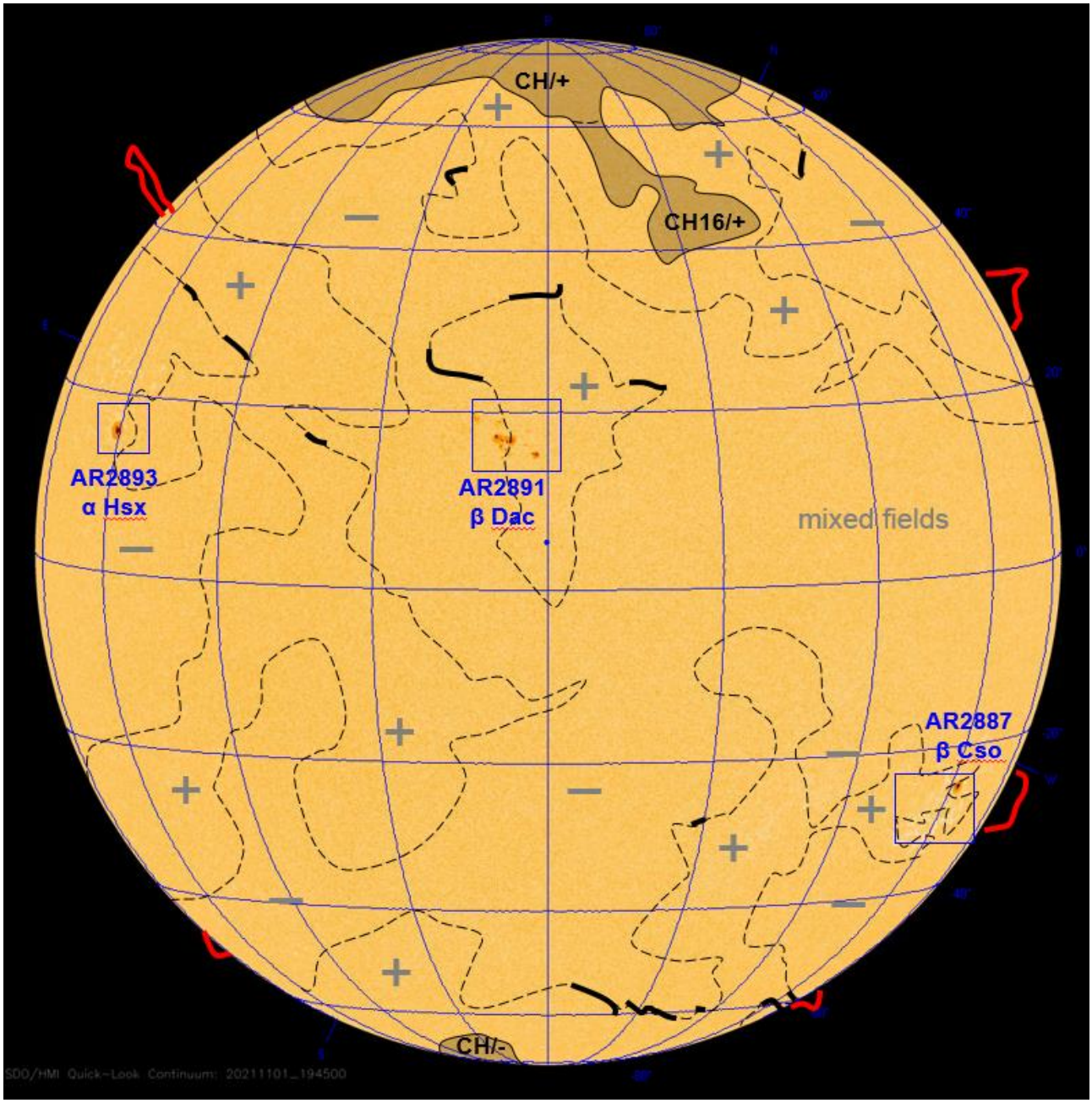
Figure 1. Solar Analysis Valid *.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The solar wind environment appears to be exhibiting signs of a transient CME arrival at earth, although the data is currently indeterminate and will require further analysis. Assuming that the data indicates a CME arrival, there is a risk of Active intervals or G1/Minor Storms on day 1, with magnetic field strength at moderate levels and solar wind speeds increasing.

Coronal hole 16, an extension of the northern polar crown is then expected to connect with earth on day 2, with speeds of around 500km/s possible, based on STEREO A data. There is also a risk that a CME which left the sun on 31st October may glance the earth on day 3, with a risk of a further glance from a CME which left the sun on 1st November glancing earth on day 4.

Generally Unsettled activity is likely through the forecast period due to a combination of the high speed stream connections and possible CME arrivals. There is a slight chance of Active intervals or G1/Minor Storms throughout the period, due to the shocks and an subsequent effects of a CME, and also due to the potential shock of the high speed stream.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
31/1628	Partial	C3 Flare	AR2891	490km/s	03/2100UTC	Possible glancing blow

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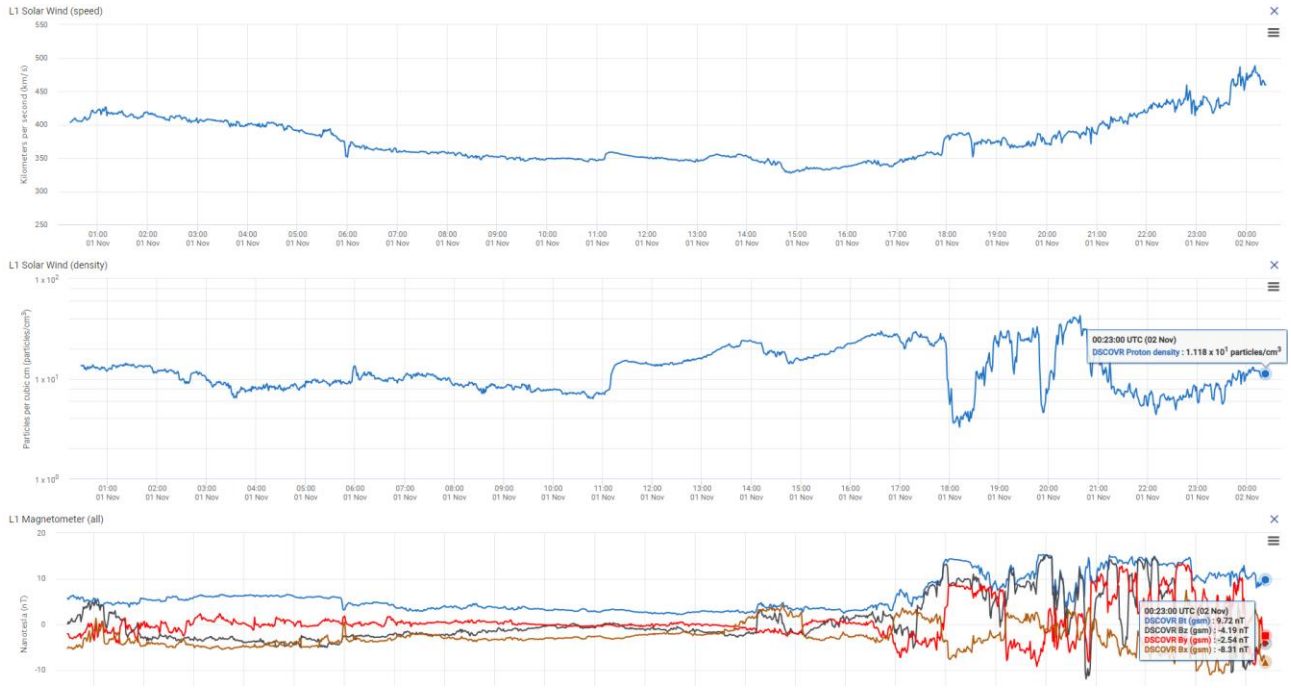
Figure 2: Solar wind parameters for the last 24 hour from DSCOVR, with the shock at 01/1755UTc clear discernible.


L1 Solar Wind (speed)
Kilometers per second (km/s)
L1 Solar Wind (density)
Particles per cubic cm (particles/cm³)
00:23:00 UTC (02 Nov)
DSCOVR Proton density : 1.118 x 10¹ particles/cm³
L1 Magnetometer (all)
Nanoteslas (nT)
00:23:00 UTC (02 Nov)
DSCOVR Bt (gsm) : 9.72 nT
DSCOVR Bz (gsm) : -4.19 nT
DSCOVR By (gsm) : -2.54 nT
DSCOVR Bx (gsm) : -8.31 nT

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Radio Blackouts - X-Ray Flares:
Solar activity is expected to be mainly low, with an ongoing risk of C-class flare activity and a lower chance of M-class flares. The main risk region is AR2891 (Dac/Beta), which is close to the northern hemisphere meridian and has demonstrated some increasing complexity over the last 24 hours. AR2887 (Cso/Beta) has a history of significant flare activity and has recently produced C-class flares and CMEs as it approaches the southwest limb.

AR2893 (Hsx/Alpha) in the northeast quadrant appears to be benign with no signs of significant development.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	20	20	20
Very Active	R3 to R5 X Class	No	5	2	2	2

Figure 3: GOES-16 X-ray flux

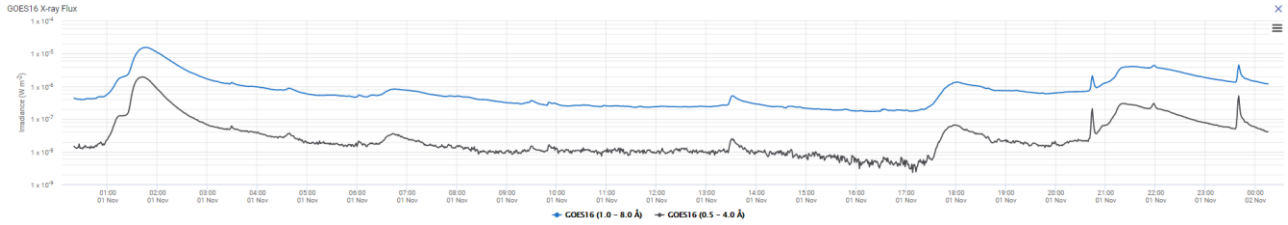
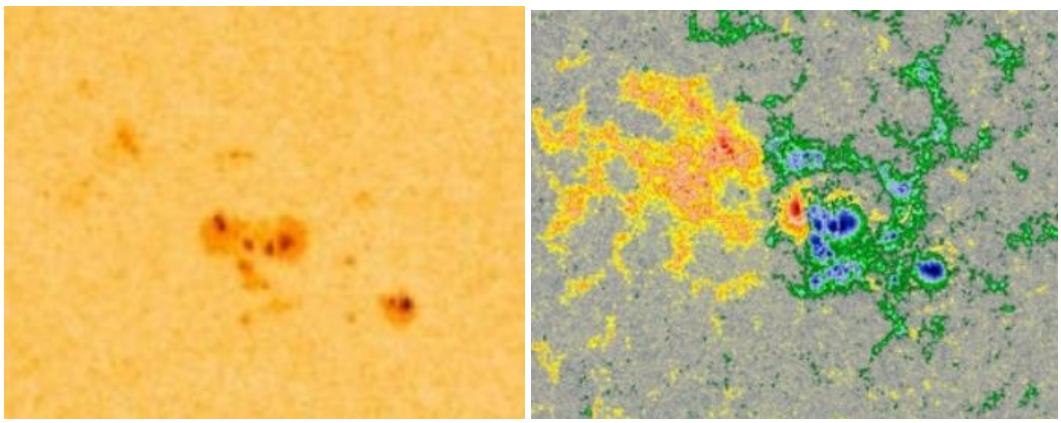


Figure 4: HMI SDO intensitygram and magnetogram imagery of AR2891 (Dac/Beta)



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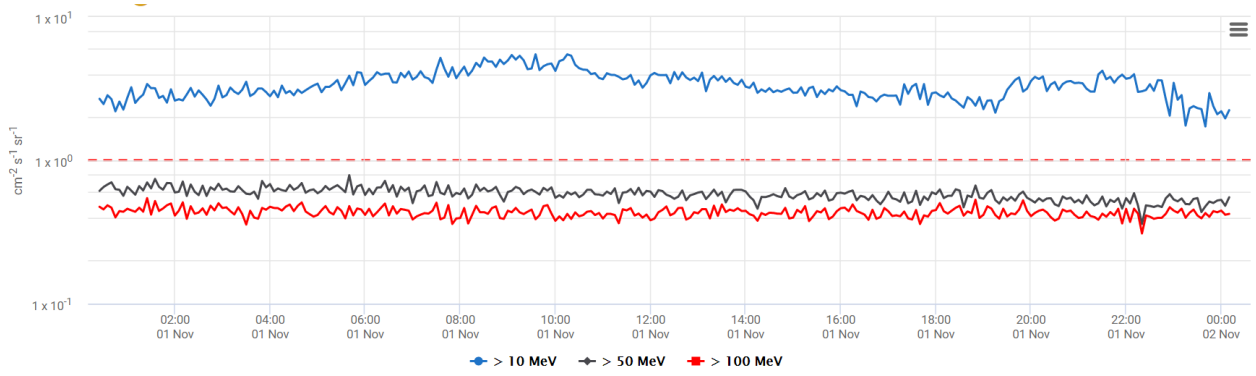
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is below S1/Minor storm levels. The trend has remained steady for the last 24 hours, with brief slight elevations in the values of the lower energy protons, most likely due to the M-class flare on 01 November. Further minor enhancements from significant flaring remain possible.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-16 Proton



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High Energy Electrons Event (≥ 2MeV):
High energy electrons (greater than 2MeV) are currently at mainly background levels, with brief increases to moderate values, with no significant increases expected on day 1. The high speed stream from coronal hole 16 on day 2 may then lead to an increase in values through days 3 and 4, perhaps reaching sustained moderate, occasionally high levels. However any increase is subject to potential CME arrivals on days 3 and 4, which may glance the Earth and lead to a disruption of the radiation belts.

Electron fluence values are forecast to remain below the Active (1e8 integrated fluence) threshold through much of the forecast period, with a rising trend possible through days 3 and 4.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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